AVIAN DISEASES 47:1169–1176, 2003

Descriptive and Surveillance Studies of Suppliers to New York and New Jersey Retail Live-Bird Markets

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Received 14 April 2002

SUMMARY. Low pathogenicity avian influenza virus (AIV) H7N2 has been isolated since 1994 from retail live-bird markets (LBMs) in the northeastern United States. This study examines the suppliers to the LBMs in New York and New Jersey. In 2001, 185 supplier premises in nine states were surveyed for the presence of AIV by virus isolation (VI) in embryonating chicken eggs. No H7 or H5 virus was isolated. In addition, 104 producer premises in two states were serologically negative for H7 and H5 AIV. Information on management practices was obtained via questionnaire for 191 premises in 12 states. The survey results suggest that current biosecurity practices at supplier premises could be improved, especially regarding movement of birds. The study supports the hypothesis that H7N2 AIV is primarily maintained within the LBMs and, if reintroduction from suppliers is occurring, it is likely retintroduced at a very low level or from suppliers not included in this study.

RESUMEN. Estudios descriptivos y de vigilancia de los abastecedores de los mercados de aves vivas en Nueva York y Nueva Jersey.

Los virus de influenza aviar de baja patogenicidad H7N2 han sido aislados desde 1994 en mercados de aves vivas del Noreste de los Estados Unidos. Este estudio examina a los abastecedores de dichos mercados en Nueva York y en Nueva Jersey. En el año de 2001, se tomaron muestras de los predios e instalaciones de 185 abastecedores en nueve estados para detectar la presencia de virus de influenza aviar mediante aislamiento viral en huevos embrionados de pollo. No se aisló virus de los subtipos H7 ó H5. Además, las instalaciones de 104 productores en dos estados fueron serológicamente negativas para virus de influenza H7 y H5. Se obtuvo información sobre prácticas de manejo a través de cuestionarios para 191 predios en 12 estados. Los resultados del muestreo sugieren que las prácticas actuales de bioseguridad de los abastecedores pueden mejorarse, especialmente con relación al movimiento de aves. El estudio apoya la hipótesis de que los virus de influenza aviar H7N2 se mantienen principalmente dentro de los mercados de aves vivas y si ocurre la reintroducción por los abastecedores, probablemente sucede en baja proporción ó por otros abastecedores no incluidos en este estudio.

Key words: avian influenza, suppliers, wholesalers, dealers, producers, retail live-bird markets

Abbreviations: AI = avian influenza; AIV = avian influenza virus; BHI = brain heart infusion broth; C&D = clean and disinfect; CEAH = Center for Epidemiology and Animal Health; LBMs = retail live-bird markets; LP = low pathogenicity; NVSL = the National Veterinary Services Laboratories

This proceedings manuscript documents a poster presentation given at the Fifth International Symposium on Avian Influenza, April 14–17, 2002, The University of Georgia, Athens, GA, USA.

Table 1. Number and percent of participating suppliers by type and state.

State	Number participating	Percent
Pennsylvania	149	78
New Jersey	11	5.8
New York	18	9.4
New England (Maine, Massachusetts, Connecticut, Rhode Island, New Hampshire)	9	4.7
Other states (North Carolina, Delaware, Maryland, Ohio)	4	2.1
Supplier type		
Farm/producer	144	75.4
Dealer	19	10
Wholesaler	8	4.2
Auction	14	7.3
Trucker	6	3.1
Total suppliers	191	

Low pathogenicity (LP) avian influenza virus (AIV) H7N2 has been isolated repeatedly from retail live-bird markets (LBMs) in the northeastern United States since 1994. Presence of this virus in the LBMs poses a significant risk to the commercial poultry in that region. Additionally, the virus has undergone several genetic changes at or near the hemagglutinin cleavage site that could lead to an increase in virulence if the virus is left to circulate, unabated, in the LBMs (4). In 1999, the United States Department of Agriculture established a LBM Working Group to provide support to the states in developing a plan to eliminate the H7N2 virus from the LBM system in the northeastern United States. Recommendations from the Working Group included conducting an epidemiologic study to identify possible risk factors for LP AIV entrance to and maintenance in the retail live-bird marketing system. The epidemiologic study was designed in two phases: Phase 1 examined the LBMs; and Phase 2 surveyed suppliers to the LBMs. Phase 1 will be presented elsewhere (1). Phase 2 was designed as a descriptive cross-sectional study of the practices of suppliers (wholesalers, dealers, poultry auctions, and producers) to the live-bird marketing system and to determine if H7N2 AIV is present within this system.

MATERIALS AND METHODS

A supplier database was compiled from sources identified by owners/managers of LBMs, sources known to federal and state personnel (including approved poultry dealers or haulers), frequent poultry auction buyers, and producers testing for AI (regularly or sporadically). It is likely this database does not include all suppliers to the LBMs, most significantly suppliers who are not licensed and may not be adhering to state import testing requirements. Suppliers were defined as 1) producer: an operation involved in the raising of birds which enter LBMs, 2) dealer: an operation that is primarily involved in trading birds in the live-bird marketing system by acquiring birds from multiple flocks and/or geographic areas for resale to another dealer, distributor, or retailer, 3) wholesaler: an operation with a permanent facility that buys from producers, dealers, or auction markets, then resells and/or delivers to the LBMs, 4) auction market: an operation where producers, dealers, distributors, wholesalers, and retailers can meet to purchase, sell, and trade birds in the live-bird marketing system channels, 5) trucker: an independent business or individual that hauls birds from producer premises to other supplier premises or to the LBMs.

Two hundred suppliers were selected for inclusion as follows: 1) all known wholesalers, 2) all known poultry dealers, 3) all producers that directly supply the LBMs, 4) all producers, in states other than PA, that test for avian influenza to meet New York LBM import requirements, and 5) in Pennsylvania, producers sporadically or regularly testing for avian influenza were selected using a random-number table until a total of 200 premises for the study was reached. In participating states, auction markets from which birds are likely to be sold into the live-bird marketing system were included in addition to the 200 premises. Prior to the survey, most suppliers were sent information that included 1) a cover letter explaining the study, 2) why avian influenza is of concern, and 3) a fact sheet on highly pathogenic avian influenza. Data analysis was done by a National Animal Health Monitoring System epidemiologist in Fort Collins, CO, using SAS software.

Epidemiologic study. From August 6 to November 30, 2001, over 200 suppliers were contacted. Of those contacted, 191 suppliers in 12 states (Table 1) agreed to participate. The total number participating represented 144 producers, 19 dealers, 8 wholesalers, 6 truckers, and 14 auctions. Primary reasons for refusal included being out of business or not wanting involvement with the government. Questionnaires were primarily administered in person with telephone follow-up as needed. When possible, bird sources were verified by viewing a receipt. Suppliers with no birds on their premises at the time of the study were included. At auction markets, a modified questionnaire was used that eliminated questions that would not apply and additional questions regarding auction activities were asked (e.g., usual number of consignors, "parking lot" sales of birds).

Table 2. Number and percent of supplier premises sampled for avian influenza by supplier type and state. I) Pooled swab samples for virus isolation. II) Serum samples for agar gel immunodiffusion.

I State	Number of pooled samples (tubes)	Number of premises tested	Percent of total premises tested
New England (Connecticut, Massachusetts, Rhode Island)	59	6	3.2
New Jersey	147	10	5.4
New York[A]	259	18	9.7
Pennsylvania	1724	148	80
Other states (Delaware, Maryland, North Carolina)	36	3	1.6
Supplier type			
Farm/producer[A]	—	144	77.8
Dealer	—	17	9.2
Wholesaler	—	7	3.8
Auction	—	13	7.0
Trucker	—	4	2.2
Total tested	2225	185	

II State	Number of premises sampled	Number of serum tubes tested	Percent of total serum samples tested
Pennsylvania	92	2202	89.9
New York	11	223	9.1
New England	1	25	1
Total	104	2450	

[A]No H5 or H7 AI viruses isolated. One producer premise H6N4 and H?N2 isolated (ducks); one producer premises H4N6 isolated (ducks).

Sample collection. Concurrent with questionnaire administration, samples were collected for virus isolation at 185 of the 191 supplier premises in nine states (Table 2.I.). This sample size allowed a 95% confidence of detecting at least one infected supplier assuming a true prevalence of 1% or higher. Most (80%) sampling occurred on premises in Pennsylvania. In general, 50 bird swab samples (25 tracheal and 25 cloacal) were collected per premises by sampling 25 birds. This sample size allowed 95% confidence of detecting one positive sample if the premises infection prevalence was at least 10%. Only cloacal swabs were collected from waterfowl; therefore, additional waterfowl or other birds may have been sampled to achieve 50 bird samples. Fewer than 50 bird samples were collected at some premises due to lack of birds. If a supplier usually had birds but no birds were present at the time of the study, environmental samples were obtained. Premises that usually did not have birds present (e.g., dealers who ship directly from farms to LBMs) were not tested.

Selecting birds for sampling was based on the following criteria, in order from highest to lowest priority: 1) five birds per lot (a group of birds of the same type that arrived from the same source on the same day), 2) birds that have been on the premises for 1–5 days, 3) sick birds, 4) lots with less than five birds. Pigeons were not tested. In addition, 10 environmental samples were taken from wet and dirty areas such as drains in bird areas, waterers, trucks, and floors. When possible, five additional swabs were taken from empty crates, selecting dirty returned crates if present. Swabs were pooled by lot, type of bird, and sample type (tracheal, cloacal, environmental) up to 5/tube, in approximately 2 ml of brain heart infusion broth (BHI).

At auction markets, 2–3 birds per lot were sampled for a total of 50 bird samples. This modified testing protocol was used to permit testing of more lots, thus obtaining a better representation of the auction population on that day. Tracheal and cloacal swabs were pooled in tubes containing BHI broth. Ten environmental samples were taken from the bird area from wet and dirty areas such as drains, waterers, and floors. When possible, five swabs were taken from trucks containing bird crates. Sampled bird-hauling vehicles ranged from station wagons and pickup trucks to tractor trailers. Crates, truck beds and bird contact areas were also swabbed.

Serum samples for agar gel immunodiffusion testing were collected at 104 producer premises (Table 2.II.). In general, 25 serum samples were collected per premises from the same birds swabbed for VI. Blood was not collected at other supplier types because of concerns of decreased bird marketability due to hematomas.

Samples were collected, packed with frozen gel

Table 3. Bird types present on supplier premises in the previous 12 mo.

Bird type	Number of premises primary bird type present	Percent of study premises primary bird type present
Laying hens	38	22
Broilers	65	37.6
Roosters	11	6.4
Other chickens[A]	4	2.3
Guineafowl	9	5.2
Ducks (all types)	19	10.9
Pigeons	3	1.7
Pheasants	1	0.6
Geese	1	0.6
Quail	1	0.6
Other[B]	21*	12.1

[A]Other chickens = silkies, cornish hens, bantams, frizzles, and unknown types.
[B]Other = turkeys, peafowl, chukars, and unknown (nonchickens).

packs, and shipped daily by overnight courier to the National Veterinary Services Laboratories (NVSL) Ames, IA, for virus isolation (2,3). Serum was separated from blood cells prior to shipping.

RESULTS

Surveillance in supplier channels in 2001 yielded no H7 or H5 AIV isolations from 2225 sample pools tested (Table 2.I.). AIV subtypes H6N4 and H4N6 were isolated from ducks on two producer premises. Additionally, one of the premises yielded an untypable (H?N2) AIV. One pheasant was positive for antibodies to AIV subtype H2N8; no virus was isolated from this bird or other birds from the same premises.

Birds were tested and/or questionnaires administered in states from Maine to North Carolina and as far west as Ohio (Table 1). The majority of suppliers (78.0%, $n = 149$) were located in Pennsylvania. Farms/producers were the most common supplier type (75.4%, $n = 144$). Chickens were the most common bird type on supplier premises (chickens, all types 68.3%) (Table 3) and the most common sampled (Table 4).

New bird arrivals and housing. Most supplier premises receive birds from hatcheries as day-old birds (66.7%) (Table 5). Most never received hatching eggs (97.6%), never received birds from other producer/farms (75%), dealers (91.8%), wholesalers (95.9%), or auction markets (90.6%).

Table 4. Number of pooled samples collected for virus isolation from bird types present on supplier premises in the previous 12 mo.

Bird type	Number of pooled samples (tubes) collected
Laying hens	182
Broilers (red, white, or rock)	667
Silkie chickens	128
Guineafowl	88
Ducks (all types)	164
Other[A]	382

[A]Other = roosters, pheasants, geese, quail, bantams, turkeys, chukars, other broilers, and chicken types not specified in other rows.

Arriving birds were usually unloaded directly into the house (64.1%). (Table 5). One third of suppliers (33.1%) did not know if delivery trucks were cleaned and disinfected (C&D) after delivering birds, while 38.4% said trucks were C&D (Table 5).

The majority of suppliers housed birds indoors only (63.9%) (Table 6). Very few facilities (5.0%, $n = 9$) reported contact with wild waterfowl (on two premises, birds had contact with wild waterfowl inside and outside domestic bird facilities) (Table 6). Employees wearing boots or clean coveralls in bird areas were observed on few premises (21.4%, $n = 39$ and 17.7%, $n = 32$, respectively) (Table 6). Of the delivery trucks seen, few drivers were observed with coveralls (20.3%; $n = 12/59$), boots (20%; $n = 12/60$), or disinfectant (22.8%; $n = 13/57$). Dogs (62.8%, $n = 118$) and cats (59%, $n = 11$) were the most common animals kept on a premises in addition to birds (Table 7). Rabbits were present on 20.1% of supplier premises ($n = 8$) (Table 7).

Bird disposition. One third (33%) of supplier premises sold birds directly to LBMs, including 25.2% of producers (Table 8). Over one third (36.6%) of supplier premises sold directly to dealers, and about one quarter (28.4%) sold to wholesalers. For producer premises, 43.7% sold to dealers and 28.7% to wholesalers (Table 8). One third of suppliers (21.8% of producers) delivered birds to premises other than their own. Of those, half (50.9%) visited more than one premises per day (Table 5). This includes 36.7% of producers (Table 5). A majority of birds leaving the premises were in crates picked up outside the bird housing area (61.2%). Only 4.8% ($n = 8$) of premises had birds picked up at the end of a lane or driveway, away from the bird housing. Vehicles picking up birds arrive partially loaded with birds from other

Table 5. Characteristics of suppliers regarding bird arrival.

Characteristic	Number of suppliers	Percent suppliers	Percent of farms/producers	Percent of dealers	Percent of wholesalers	Percent of truckers
Ever receive birds (day-old) from hatcheries	114	66.7				
Never receive hatching eggs	166	97.6				
Never receive birds from producers/farms	129	75				
Never receive birds from dealers	156	91.8				
Never receive birds from wholesalers	163	95.9				
Never receive birds from auctions	154	90.6				
Ever deliver birds to premises other than own	60	32.3	21.4	73.7	87.5	83.3
Of those, visited multiple premises with same vehicle in 1 day	30	50.9	36.7	57.1	100	66.7
Vehicles C&D[A] after unloading birds	66	38.4				
Vehicles not C&D[A] after unloading, or unknown	49	28.5				
Unknown if vehicles C&D[A] after unloading	57	33.1				
Arriving birds unloaded directly to house	91	64.1				
Arriving birds left in crates outside house, unloaded later	47	33.1				
Arriving birds left at end of farm lane	2	1.4				
Arriving birds handled in none of these manners	7	4.9				
Trucks bringing birds owned by supplier	49	28.5				
Trucks bringing birds owned by contractor, dealer, farm/producer	68	39.8				
Trucks owned by other[B]	67	39.2				

[A]C&D = cleaned and disinfected.
[B]Majority of trucks owned by other were owned by U.S. Postal Service.

premises on 38.6% ($n = 61$) of supplier premises surveyed. (Table 10).

Most premises required empty crates to arrive C&D (67.4%) (Table 9). Premises were C&D with a variety of compounds, with phenolic compounds most commonly used (36.1%, $n = 69$) (Table 9). Disinfectant was usually applied with a sprayer (46.5%) or power washer (44.9%) (Table 9). Most premises (72.8%) were empty of birds when C&D occurred (Table 9). Interviewers thought 66.3% of supplier premises could be adequately C&D, as could most bird-hauling vehicles (83%). The majority of wholesalers disinfected daily (71.4%). However, 13.2% of producer premises and 12.5% of dealer premises never C&D bird areas (Table 9).

Auction markets. At only 14.3% of auction markets ($n = 2$), were birds kept on the premises on nonauction days. Birds were sold in the parking lot, outside of auction channels, on rare occasions (14.3%, $n = 2$). Auctions sold a mean of 226 birds on a usual auction day, with laying hens comprising the majority of birds sold. The median number of consignors at auctions was 20, with a mean of 26. The median number of buyers was 15.

DISCUSSION

The hypotheses as to why H7N2 AIV has been isolated repeatedly from LBMs in New York and New Jersey since 1994 include 1) the virus is persisting in and circulating within the LBMs, 2) the virus is being introduced to the LBMs from suppliers, or 3) a combination of 1 and 2. No H7 or H5 AIV was isolated from supplier premises in this study. However, other AIV types were isolated, indicating the sampling protocol was likely adequate to detect H7N2 AIV if it were present on study premises. A cross-sectional cohort study of the

Table 6. Management of birds on supplier premises.

Characteristic	Number of suppliers	Percent of suppliers	Percent of farms/producers	Percent of dealers	Percent of wholesalers
Birds housed indoors only	122	63.9			
Birds housed both indoors and outdoors	38	19.9			
Birds housed outdoors only	8	4.2			
Wild waterfowl inside bird facilities	3	1.6			
Wild waterfowl outside bird facilities, but in contact with domestic birds	8	4.5			
Employees use clean/diposable coveralls	32	17.7			
Employees use disinfectable boots	39	21.4			
Have birds at another location	41	23.6	26.8	5.6	0
Of those, ever move birds between locations	17	40.5			
Of those, move personnel, equipment, vehicles between locations	28	77.8			
Dead birds buried, composted, or incinerated on site	108	57.5			
Dead birds buried, composted, or incinerated off site	10	5.4			
Dead birds picked up by renderer	5	2.7			
Dead birds go as trash or to landfill	65	34.6			
Dirty crates on premises	88	48.1	13.8	10.5	37.5

LBMs in New York and New Jersey in 2001 (Phase 1) found a market prevalence for H7N2 AIV of 56.9%.

Although the study database likely did not contain all suppliers to the LBMs, attempts were made prior to the study to expand state lists of known suppliers. Regulatory personnel in numerous states examined flock AIV testing records, auction market sales records, and worksheets from LBM AIV surveillance testing to detect additional suppliers. As a result, new suppliers and LBMs were detected. Supplier types missed might include producers and backyard flock owners selling occasionally to the LBMs, and unlicensed poultry dealers. Suppliers who regularly visit the LBMs report some markets purchase birds "out of the back of a station wagon at 3:00 am." It is possible that these unknown suppliers provide a nidus of infection from which AIV is sporadically reintroduced to the LBMs.

In addition, H7N2 AIV was discovered on several producer premises in Pennsylvania after the completion of this study. None of the infected premises had or were known to have LBM ties and were not included in the supplier database. Infection on these premises was detected at least 1 mo after the completion of this study. Other suppliers in that area were included in this study and tested negative for AIV.

The descriptive portion of this study was conducted to gain a better understanding of management practices and biosecurity of suppliers to the LBMs. There have been three introductions of LP AI to commercial poultry facilities in Pennsylvania in the past 10 years. While this study does not permit an assessment of risk, it does show biosecurity could be

Table 7. Bird marketing by suppliers.

Birds sold directly to	Total number of suppliers	Total percent of suppliers	Percent of producers/ farms ($n = 144$)	Percent of dealers ($n = 20$)	Percent of wholesalers ($n = 8$)	Percent of truckers ($n = 6$)
Auction markets	19	10.8	10.5	21.1	0	0
Retail live bird markets	58	33	25.2	63.2	100	33.3
Farms	11	6.2	7	0	0	16.7
Dealer	64	36.6	43.7	10.5	0	0
Wholesaler	50	28.4	28.7	26.3	25	33.3
Other	38	21.8	20.4	27.8	12.5	50

Table 8. Cleaning and disinfection practices on supplier premises.

Characteristic	Number of suppliers	Percent of suppliers	Percent of farms/producers	Percent of dealers	Percent of wholesalers
Premises ever empty of birds	129	67.4	63.2	61.1	75.0
Bird area C&D[A] daily	7	3.8	1.4	0	71.4
Bird area C&D[A] weekly	19	10.4	4.2	25	0
Bird area C&D[A] other time period	135	73.8	81.3	62.5	28.6
Bird area never C&D[A]	22	12	13.2	12.5	0
Used phenol disinfectant	69				
Used bleach disinfectant	15				
Used other disinfectant	27				
Don't know disinfectant type or class not determined	47				
Apply disinfectant with sprayer	87	46.5			
Apply disinfectant with power washer	84	44.9			
Apply disinfectant with mop, sponge, or other method, including foggers	37	16.1			
Birds moved elsewhere on site when C&D[A] occurs	18	10.0	8.6	17.7	50
Premises empty when C&D[A] occurs	131	72.8	72.7	61.1	50
Empty crates required to arrive C&D[A]	120	67.4			

[A]C&D = cleaned and disinfected.

improved on supplier premises to prevent the entrance of diseases such as LPAI.

Of great concern are the 25.2% of producers in this study who sold birds directly to LBMs. Even when direct movement to LBMs did not occur, ideal biosecurity practices at the time of bird arrival and departure are not practiced by the majority of suppliers. Best management practices would recommend that arriving birds be delivered away from bird housing areas, such as at the end of the farm lane, then moved into housing by farm personnel. Only 2 suppliers (1.4%) in this study followed this practice. Most unloaded birds directly into bird housing, risking contamination of the houses and premises from the driver and vehicle. Overall, few drivers were observed on farms; of these, only about 20% had clean coveralls, boots, or disinfectant. The driver could thus carry virus to the farm, between farms, or from the farm.

Almost half (48.1%) of suppliers had dirty crates on their premises. This includes 13.8% of producers. This practice is a potential source for the spread of AIV. Best management practices would include immediate return of empty crates to the bird supplier, or that only properly C&Ded crates be kept on the premises.

Very few suppliers in the study followed the practice of having birds picked up at the end of a farm lane, or otherwise away from the bird housing area (4.8%). The percent of producers that had birds picked up by LBM personnel was not determined. In addition, 39% of suppliers studied indicated that load-out vehicles arrived partially loaded with birds from other premises. Over one third (36.8%) of producers' and dealers' (38.9%) premises said they are never empty of birds, suggesting that partial load-outs may occur. Some producers (13.2%) and dealers (12.5%) never C&D the bird areas. These practices may permit direct bird-to-bird spread of AIV.

While over one quarter (28.5%) of suppliers said

Table 9. Characteristics of vehicles used to remove live birds from supplier premises.

Vehicle characteristic	Number of suppliers	Percent of suppliers
Owned by supplier	64	37.4
Owned by retail market	5	2.9
Owned by contractor	45	26.3
Owned by dealer	51	29.8
Owned by other	25	14.6
Arrive empty	126	79.7
Arrive partially loaded with birds from other premises	61	38.6
Arrives visibly C&D[A]	99	65.6
Arrives empty but not clean	7	4.8

[A]Cleaned and disinfected.

Table 10. Other animals kept on bird premises.

Animal type	Number of premises with animal type	Percent of premises with animal type
Rabbits	38	20.1
Guinea pigs	19	10
Cattle	83	43.9
Sheep	33	17.5
Goats	28	14.8
Pigs	38	20.1
Cats	111	59
Dogs	118	62.8
Pet birds	10	5.3
Other[A]	22	11.6

[A]Majority of "other" was horses.

incoming trucks were not C&Ded after unloading birds, this may reflect the type of delivery rather than a lack of concern for biosecurity. Many producers said they received day-old chicks by mail, with birds being delivered in U.S. Postal Service vehicles. Postal Service vehicles are not routinely C&Ded.

In this study, 20.1% of supplier premises had rabbits present (Table 7). The Phase 1 cross-sectional cohort study of LBMs showed having had rabbits in the market during the past 12 mo increased the risk of AIV infection (adjusted odds ratio = 4.1, $P = 0.004$). The increased risk could be due to some undetermined factor regarding the rabbits themselves or that LBMs that sell rabbits differ from markets that do not by some undetermined factor. The role of rabbits in AIV maintenance or transmission should be examined further to determine if they represent a biosecurity risk.

Lack of virus isolation from birds at auctions, combined with consistently historically negative surveillance testing, may indicate AIV is not persisting in a majority of backyard flocks or at small production premises. In addition, few birds at supplier premises in the study (6.1%) had contact with wild waterfowl. If suppliers not included in the study database (e.g., occasional suppliers or unlicensed dealers) are similar to the study suppliers, it is possible that H7N2 or other AIV 1) is transmitted from LBMs to supplier premises on fomites or via returned birds, 2) is maintained on supplier premises by bird-to-bird spread, and 3) is then reintroduced to the LBMs during occasional purchases from these suppliers. The difficulty of identifying these occasional, unlicensed suppliers hinders future studies on their role in AIV transmission in the live-bird marketing system. However, this study, when combined with information obtained in Phase 1, supports the hypothesis that H7N2 AIV is primarily maintained within the LBMs. If reintroduction from suppliers is occurring, it is occurring at a very low rate or else is from suppliers that were not a part of this study.

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ACKNOWLEDGMENTS

We wish to thank Amy Nesselrodt, Beth Wittenbrader, Lech Szkudlarek, Glen Bailey, and the many other state and federal veterinarians and animal health technicians who assisted with this project.